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ABSTRACT

This report is a study of the training implications of technological change in manufacturing in Yugoslavia. Part 1 analyzes the general technological and educational infrastructure in Yugoslavia. The sources of technology as well as the present state and future prospects of technological research are described. Education is discussed in terms of its response to technological change. Part 2 contains five case studies of firms that were developing or introducing new technology on a considerable scale. Each study is presented in two sections. In the first, problems and findings are given. In the second, conclusions are reached and certain International Labour Office hypotheses are tested. Part 3 presents generalizations based on the case studies, including the following: firms greatly affected by technological change have a good production and marketing record; personnel skills and abilities influence strongly the successful introduction of new technology; the government does not actively support innovation; the current economic situation hinders expansion and development of the educational system; industry plays a strong role in determining educational curricula and in the enrollment policies of universities; and the companies have good connections with foreign firms for cooperation, acquisition of technology, technical backup, and some training. (YLB)

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TRAINING POLICIES

Discussion Paper No. 15

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE CASE OF YUGOSLAVIA

by

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Note: Discussion papers are preliminary material circulated to stimulate critical discussion and critical comment.

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PREFACE

Presentation and methodology

The main subject of this study is the "training implications of technological change" in manufacturing in Yugoslavia, and it focusses on firms and sectors where considerable technical changes have occurred.

The report consists of three main parts. Part 1 analyses the general technological and educational infrastructure. Part 2 contains five case studies and Part 3 presents generalisations based on these studies.

In order to reach reliable conclusions and findings representative of the economy as a whole within the allocated time and financing of the study, it was necessary to limit the investigation to a select sample of firms and to incorporate additional information from other sources.

Field research on the subject is difficult from many points of view: first, it is not easy to get the co-operation of a firm's personnel, they being occupied with everyday duties and problems; second, the subject is sensitive and a strict a priori method of research assuring reliable results is difficult to devise.

With these points in mind, seven firms were selected which are developing and/or introducing new technology on a considerable scale. All these firms are from the Socialist Republic of Serbia, whose level of economic and technological development can be considered representative of the country as a whole.

The selected firms have been studied in depth, but two of them did not grant unrestricted use of their data and findings so this report is limited to five case studies. Each study is presented in two sections. In the first, problems and findings are given. In the second, conclusions are reached and certain ILO hypotheses are tested.

In order to reach valid general conclusions, the technological and educational infrastructure of each firm is described separately.

The co-operation and advice provided by Mr. Torkel Alfthan and Mr. Michail Bermant of the ILO have been of utmost value in the completion of this report. However, the authors take responsibility for any shortcomings in this study.

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE YUGOSLAVIA CASE

PART 1

TECHNOLOGICAL INFRASTRUCTURE

The technological infrastructure of any macro- or micro-system comprises

a) Its capital investment;
b) Its human resources; and
c) The dissemination of technological information.

This infrastructure can take on different configurations, depending upon the following important criteria:

a) The quality, i.e. the competitiveness of the technology;
b) The sources of technology -- domestic or foreign;
c) The balance between various types of technology; and
d) The compatibility of actual technology used in industrial and non-industrial sectors.

Competitiveness in domestic and world markets depends on the development of technology which is non-intensive in the use of materials and energy, such as micro-electronics, robotics, etc. This is replacing or revitalising older technology which, by contrast, is high in the use of energy and is not heavily demanding in research.

THE SOURCES OF TECHNOLOGY

The source of available new technology is to a large extent foreign, particularly that relating to the computer sciences. For a long time, Yugoslavia considered that the import of technology was economically justifiable. Many technological processes of foreign origin, however, have restricted uses and are highly dependent on foreign supply of raw materials and components. As older technology is easily available on the international market, a great deal of equipment has been imported that has become more or less obsolete. During the last several years, it has been realised that such a policy of acquisition is acceptable on a short-term basis but is very vulnerable for the mid- and long-term. Accordingly, political and other measures have been enacted to stimulate domestic production of technology.

For many years, the Yugoslav economy has been supplied primarily with technology for the development of capital goods. There is therefore a dearth of new electronic and computer technology. Educational and training systems have emphasised the social sciences and humanities to the detriment of physics, chemistry, mathematics, biology and technical subjects. On-the-job training was similarly undervalued. Research and development departments, even if they existed, dealt with activities more or less remote from practical application.

The climate has been improving rapidly over the last several years but it takes time for change to materialise.

The so-called "structural competitiveness" of the Yugoslav economy is below required levels. Some sectors are technologically fairly competitive such as the machine tool industry, electric machinery and equipment, energy transmission equipment, etc. However, their capacity is limited by the low technological levels of other industries, such as metallurgy, the chemical industry, control and measurement manufactures, as well as the computer industry. The actual competitive weakness of the economy is the main barrier to technological progress and the main reason for technological dependence on foreign sources.

Recognition of this problem has led to efforts to develop domestic supplies of generic technology primarily in the fields of computers, micro-electronics, software and new materials.

TECHNOLOGICAL RESEARCH

A short description of the present state and future prospects of technological research follows:

Most of Yugoslavia's technological researchers are still involved in the actual practical use of technology, rather than in research and development. However the number of scientists involved in R & D is increasing.

There are three main types of organisations producing new technology:

a) Independent research and development institutes
b) University research laboratories and groups
c) R & D centres and departments within industrial organisations. These account for about 18% of the total number of research centres.

The independent institutes work largely on behalf of industry and other users, but university research projects have been divorced from practical industrial problems for many years. Recently closer co-operation has been developing between all three groups and toward further development of the country's research potential. We can

conclude that the actual allocation of R & D potential is not fully suitable for an aggressive industrial and technological strategy, but the development of research organisations within industry and closer co-operation between these and other research centres is a move in the right direction.

Most R & D centres at this time are concentrated in the larger cities, but decentralisation is gradually taking place.

There are three main methods by which R & D is financed. First, all organisations doing research and development and all beneficiaries of their activity are organised into Associations for Self-Management Interest in Science (ASIS). These are legally compulsory at the level of autonomous regions and republics and also mandatory at county and community level. They are established for specific economic sectors on the so-called functional principle. The ASIS assemblies decide on the allocation of income payable by participating firms and on the distribution of the funds for specific plans and programmes. This source of R & D finance amounts to about 0.3% of the country's GDP.

The second source is industry which directly funds its own R & D centres or underwrites the cost of research at R & D institutes or universities. This financing amounts to about 0.7% of the country's GDP. The third source is the direct investment by industry in outside R & D organisations, but this is rare. There are further sources of finance, including bank credits for R & D, but they are minor.

Neither the federal nor the state governments have funds to finance R & D.

The acquisition of foreign technology is completely in the hands of industrial firms. Subject to Government regulations, these firms decide what to buy, under what conditions, at what price and for what purpose it will be used.

Summarising, one can say that the acquisition, use, distribution and financing of new technology lies almost entirely with industry and other commercial organisations. They in fact decide how much of national GDP will be used for R & D and for acquiring foreign know-how and equipment. There is, however, a trend toward developing indigenous sources for new technology in line with a policy of greater technological independence.

EDUCATION AND ITS RESPONSE TO TECHNOLOGICAL CHANGE

The main divisions of the educational system are:

a) Pre-school education;
b) Eight years universal compulsory education;
c) Secondary professional education;
d) Higher and university education.

The secondary educational system for teen-agers and adults has the aims of 1) developing the education and skills needed for employment and 2) preparing for higher and university level. It has two parts. The first preparatory two years are intended to provide basic education in the humanities, social and natural sciences, and technology. The second part is professionally oriented, preparing for productive employment and further education. This generally lasts two years. Under exceptional circumstances, it can be started in the last year of the basic course, thus reducing the overall period of study by one year. Training is offered for 37 different professions and 560 different jobs within these professions.

This secondary education is provided by the following institutions: secondary schools, so-called Educational Centres (a special form of educational institution), and peoples' and workers' universities which provide adult education. The former "gymnasia" were abolished to concentrate on production-oriented secondary education.

Some reform of vocational education is currently taking place because:

1) Insufficient hours were allocated to practical work and lectures, resulting in inadequate preparation for productive work;
2) The number of professions and jobs taught were out of proportion with actual industrial needs;
3) The majority of secondary students were found to be seeking enrollment in already-crowded universities rather than productive employment; and
4) Yugoslavia's economic difficulties have resulted in a reduction of financial and material support for the entire educational system.

University education is similarly expected to undergo radical reform to meet the needs of technological change.

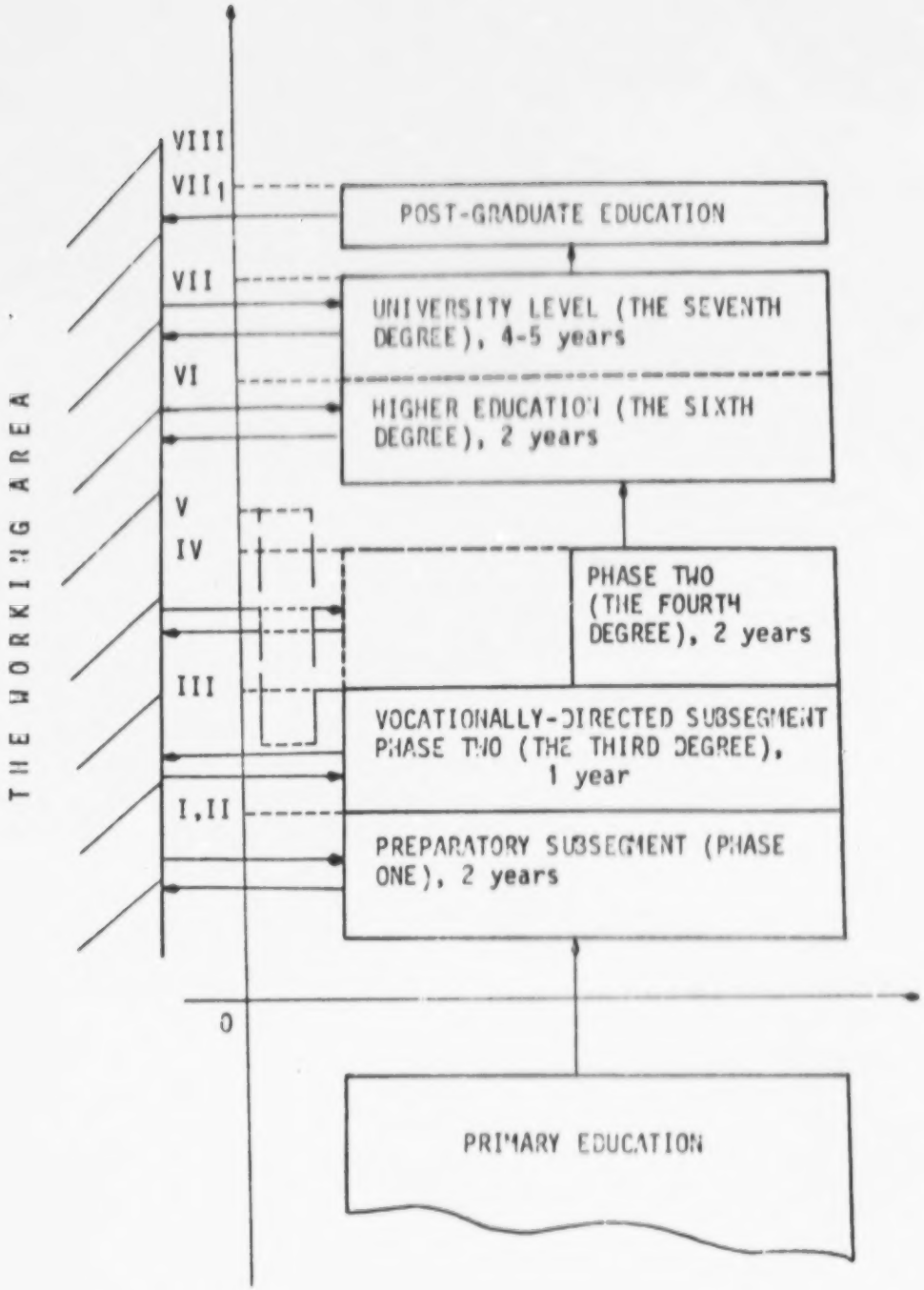
The country's system of adult education is in close contact with the needs arising from technological change. It emphasises that it should become democratic and permanent with every employee having the right to be educated while employed and to be allowed time off for instruction, and that the principles of solidarity should play a major role in the allocation of funds so that those who are socially or financially disadvantaged can obtain an education.

The country's peoples' and workers' universities have been established on a geographical basis. The Educational Centres are located according to the needs of production, while secondary schools follow the normal education pattern. The peoples' and workers' universities are very flexible and mobile. They organise programmes at almost any location, although mostly inside industrial organisations, and they are adaptable to local needs with regard to the times and duration of courses.

The figure on the following page gives an overview of the educational system.

The country's decentralised university system is extensive. It is attempting to keep up with worldwide scientific and technological progress but it has many structural, financial and equipment problems reflecting a need for radical reform which is slow in coming.

In fact, the reaction of the entire educational system to new educational and training needs has been slow; the frequency of change in educational programmes is inadequate; and there is still no permanent education and training to serve the specific needs of industrial organisations and technological change. There is some exchange of information about new technologies, mainly in the peoples' and workers' universities and in professional societies, but only rarely within the regular educational system.


THE WORKING AREA
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POST-GRADUATE EDUCATION
UNIVERSITY LEVEL (THE SEVENTH DEGREE), 4-5 years
HIGHER EDUCATION (THE SIXTH DEGREE), 2 years
PHASE TWO (THE FOURTH DEGREE), 2 years
VOCATIONALLY-DIRECTED SUBSEGMENT PHASE TWO (THE THIRD DEGREE), 1 year
PREPARATORY SUBSEGMENT (PHASE ONE), 2 years
PRIMARY EDUCATION

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE YUGOSLAVIA CASE

PART 2
CASE STUDIES

EXPLANATORY NOTE

At the end of the following case studies, 13 hypotheses, provided by the ILO, were tested. The hypotheses are as follows:

1. The firm has a good past record of marketing new/adapted products or introducing new/adapted processes.
2. The firm exhibits considerable flexibility in work organisation/labour use/deployment of labour.
3. The Government strongly supports technological innovation/introduction of new technologies by industrial policy measures.
4. The firm is able to recruit and retain personnel at the desired levels of recruitment.
5. Personnel skills are a determining factor for success in market competition.
6. Some skills/personnel groups are more important for company survival/success than others.
7. The new technology has meant genuine skill enhancement.
8. The firm has a high ratio of research/skill intensive manpower to total workforce.
9. The Government strongly supports development of skills for high-technology industries by means of training and educational policy measures.
10. The firm has maintained close collaboration with university and education and technical training institutions and has influenced their courses to mutual benefit.
11. The firm has strong affiliations with foreign firms and/or institutions providing technological backup and training.
12. The firm acts as a considerable "diffuser" of skills to subcontracting/supplying firms.
13. Trade unions or workers' representatives actively participate in decision-making regarding employment, training and output.

ZASTAVA CAR FACTORY (ZCF)

Data, Problems and Findings

The Zastava Car Factory (ZCF) is the largest Yugoslav manufacturer of passenger cars with an annual output of 170,000 units. ZCF is part of the Zavodi Crvena Zastava Corporation, one of the largest industrial organisations in the country.

ZCF started manufacturing cars in 1957 under a licensing agreement with FIAT and it has grown to become an independent producer. Its products fill 70% of domestic demand and its cars are exported to Eastern, Western and other markets. As from 1986, about 50% of output is scheduled to be exported to European and U.S. markets.

ZCF's technological development is directed toward two basic goals: first, to achieve a satisfactory level of technical independence, and second, to introduce and develop new technology, a predominant characteristic of the automobile industry.

The development and application of up-to-date technology, the effort to remain competitive on existing markets and acquire new ones, as well as other important problems of the automobile industry, have had a radical influence on the knowledge, skills and techniques of employees. ZCF is a typical example of a firm in a sector strongly affected by new research-intensive technology in the fields of new materials, micro-electronics, new energy sources and conservation, computer-aided design and computer-aided manufacturing. The implications of the development and introduction of new technology on the training and development of ZCF personnel are common to all established manufacturers who have, in the past few years, found technological change and modernisation essential for survival. Competitive challenges on both the domestic and world markets can only be met by adequate changes in technology.

ZCF has 15,500 employees, of whom 3.7% are university graduates, 4% have a college education, 9% have higher education, 40% are skilled workers and 43% are semi-skilled or non-skilled workers. The factory has a decentralised structure, comprising 10 income centres or independent units known as Basic Organisations of Associated Labour (BOAL). This means that several hundred people hold management positions. The factory has its own research institute which develops new components, products and processes and performs laboratory experiments. ZCF has about 200 suppliers of parts.

Personnel planning is done for the short-, middle- and long-term. New employees are mostly between 18 and 22 years old, being semi-skilled or skilled workers or young people with college or university degrees. They are mainly from schools in the city of Kragujevac, or

from the University of Kragujevac with a considerable number of graduates from the faculty of mechanical engineering. Other new employees come from other universities, from other firms or are new arrivals from rural areas.

To get the required manpower, ZCF offers scholarships or loans to high school and university students. For those employees who undertake education or training at the same time as they are working, the company offers such advantages as shorter working time, help with their education and training fees and financing of the costs of theses for doctorates or masters' degrees.

The frequent changes in technology mean that there are also educational changes vertically (from lower to higher levels) and horizontally (from one educational field to another). In-house training for workers lasts from one to six months and is intended to bridge the gaps in knowledge between school and the needs of the factory. This training does not lead to a certificate of qualification. It aims primarily at bringing students up-to-date with the latest changes in technology.

Technological changes at ZCF have given rise to two important problems. First, older workers face problems in adapting to constant technological change, particularly if the changes necessitate employing young manpower who are more able and productive. Because of the system of social ownership in the Yugoslav economy and the system of workers' management, there are very strong legal and moral barriers to firing workers who are technologically "obsolete". The second problem is on the production side. Because it is not possible to fire workers but at the same time there is a need for younger workers with more advanced technological background, the firm faces a problem of surplus labour, i.e. structural unemployment coupled with a shortage of qualified staff.

At this time, the greatest demand is for workers and technicians in electronics. Since there is no proper school for electronics in Kragujevac, more than 80% of this labour need is met by the technical school in the city of Niš, a centre of the electronics industry. Bearing in mind the aim of exporting 50% of its products to hard currency markets abroad, ZCF will require a radical restructuring of technological education and training from top management to the shopfloor. It is doubtful that the changes can be effected adequately with the existing personnel. Despite numerous warnings, the educational and training arrangements in the firm, in the region and sector are adapting very slowly to the changing needs.

Conclusions & Test of Hypotheses

1. Up to five years ago, ZCF had almost no problems on the domestic market. The import of raw materials, intermediate products, components and assembly parts from abroad was relatively easy and so the firm did not have to export. However, recently ZCF has had to find foreign hard currency markets in order to survive. This problem highlights the entire problem of technological change, product quality and introduction of new models. With a secure local market for a long time, the firm was not obliged to introduce new products and processes. This has now all changed.

2. The very nature of automobile production prevents the firm from making too frequent radical changes in work organisation. The firm is inclined to be flexible in organising its work and production and several reorganisations have been attempted. But none of the plans was fully carried out, a major reason being the lack of organisational ability and the heavy restrictions on the firing or reallocation of labour.

3. As far as Government support of technological innovation is concerned, the Government remained outside technology and innovation policy-making for a long time. Development of domestic technology was not considered to be of Government concern. This was one reason why car manufacture in Yugoslavia was fully dependent on imported technology, machinery, know-how and licensing. Several years ago, the Government changed its attitude and it now encourages domestic development of technology, although this is accomplished mostly by discouraging foreign imports.

So far there has been no direct Government financial support for technological innovation. However, some indirect measures are to be undertaken: stimulation of international technological co-operation; deduction of import taxes on equipment intended for competitive technological innovation; abolition of taxes on R & D activity, etc.

4. The firm is able to recruit and retain personnel at the desired levels.

5. Personnel skills are a determining factor for success in market competition for the following reasons: First, car manufacturing is still a labour-intensive process. Second, the quality of the end product is one of the main factors for competitiveness. Third, development, acquisition, implementation, adaptation and improvement of both the product and the production processes are labour intensive.

6. The skills of personnel groups are important for the company's survival and are determined by levels and types of technology used in production and by the company's aspirations.

The present and future of ZCF is characterised by: an aggressive export policy in very competitive markets; the necessity to develop,

acquire and apply new technology; a radical expansion of production facilities; and the high quality, low price policy of the company. The involvement of personnel in the achievement of these objectives is, in decreasing order, as follows: management personnel, research and development personnel, shop floor engineers and technicians, skilled workers, information processing personnel, marketing and accounting personnel, semi-skilled workers. The first three groups will play a decisive role in the achievement of the company's goals.

7. The main innovations in car manufacturing are: computer aided design(CAD), process automation, FMS, robotics, computerized numerical control (CNC) machine tools, computer aided manufacture (CAM), new organisational technology such as zero inventory systems, and use of computers for marketing and manufacturing activities. Up to the present, ZCF has introduced either completely or in part the following: process automation, CNC machine tools, and business and production computer data processing. This has resulted in genuine skill enhancement. However further innovations to be introduced in ZCF in the near future will mean even greater improvement in skills.

8. Out of 15,500 employees, only 1.3% are engaged in research and development. Thus the ratio of research to total manpower is low, particularly in comparison with other technologically advanced car manufacturers where the ratio is approximately 4 to 5%.

9. There is very little Government involvement in the development of skills. However, it supports it through tax schemes and exemptions on income spent on training and education. No tax or social contributions are paid on the salaries of newly employed personnel in contrast to other personnel whose wages are subject to contributions up to 42%

10. In Kragujevac, the university faculty of mechanical engineering was established 30 years ago primarily to provide engineers for ZCF. Since then, close collaboration has been developed between ZCF and this faculty as regards education, research and development. Faculty members engage in research for ZCF and some ZCF specialists lecture at the faculty.

ZCF has considerable influence on the programmes in other educational and training institutions in Kragujevac, as well as throughout the entire Socialist Republic of Serbia. There are , for example, three classes in electronics at Kragujevac High School which comply with the needs of ZCZ. The firm also has close connections with the faculties of mechanical engineering at the universities of Belgrade and Niş. In general, because it is a large firm, it is influential in establishing educational programmes at universities, colleges and high schools.

However, ZCF does not have the structure and resources required for prompt and reliable reaction to changes in training needs. Until 1964, an Educational Centre existed within the ZASTAVA enterprise to supply ZASTAVA and ZCF with skilled workers. However,

with the reorganisation of the entire education system in the country, this centre was abolished and ZCF lost one of its most important sources of trained manpower.

One of the main shortcomings in ZCF is the relative lack of educational and training facilities for managers and specialists. For years, their training has been regarded as "their own problem", a policy which should be changed as soon as possible.

11. ZCF has strong affiliations with FIAT (Italy) and a large number of ZCZ specialists have received training there. FIAT, under its licensing agreement, has supplied ZCF with technological backup for a long time and affiliations with other foreign firms and/or institutions have consequently been very sporadic.

12. Due to the nature of the car industry, ZCF has many suppliers and sub-contractors (more than 200) making parts. ZCF provides many of these with technical documentation and other technology for making the components. Through these arrangements, ZCF passes on technology to many other firms and many different industrial sectors. It is consequently an important diffuser of skills and technology.

13. In the system of worker management which governs the Yugoslav economy, worker representatives have a voice in all decisions concerning education and training. Furthermore, anyone interested in education and training policy can be influential in determining its form. The same holds for the unions.

COLOUR TV CATHODE RAY TUBE FACTORY (CCRFT)

Data, Problems and Findings

The Colour TV Cathode Ray Tube Factory is a very special and interesting case for the investigation of technological change on training and education. The factory is unique in that it is new, a replacement for a black and white TV cathode ray tube plant, it is part of a big electronics corporation and it is located in a region with special industrial and educational structures. It was founded by a mutual agreement among all color TV manufacturers in Yugoslavia. The factory has a virtual monopoly on the domestic market.

The corporation "Elekronska industrija" (EI), of which CCRTF is a part, is located in Niş. This company started cathode ray tube (CRT) production in 1948 with the technical assistance of the West German Siemens company. Partly due to the cessation of black and white tube manufacture elsewhere, the company's black and white CRT production grew to such an extent it was supplying a considerable portion of the domestic market as well as exporting to many countries including Western Europe.

In 1979, it signed a licensing agreement for the production of colour CRTs with Philips. Production today is almost totally influenced by the terms of this agreement. This explains why CCRTF has not yet developed its own research and development unit.

In September 1985 CCRTF had 421 employees with the following educational and skill abilities: 11% had university education, 2% had college degrees, 20% were high school graduates, 4% were highly skilled workers, 16% were skilled workers and 42% were semi-skilled or unskilled workers. This indicates the high level of labour division and specialisation on production and use of licensed technology.

Of the 1985 production, 15% was exported, but in 1986, there were contracts for the export of 50% of output (90,000 units). The licensing agreement with Philips stipulates that CCRTF is not to export to markets where Philips is represented. CCRTF's markets are very limited so that its products must be of high quality, technically advanced and competitively priced.

Since the CCRTF factory is still being established, it is free from taxes and is less subject to import restrictions. However one can say that even these government policies do not allow sufficient new investment.

As noted above, CCRTF is part of the highly developed EI electronics corporation which is widely diversified and rather rich in experience in technology acquisition, transfer and diffusion. As a consequence, the educational system in the region has been developing for years to serve primarily the needs of EI. To this end, the faculty of electronics

was founded at the University of Niş which also includes many of the usual university departments such as mechanical engineering, medicine, economics, law, etc.

The skill structure of manpower hired by CCRTF is adapted to the licensed equipment which is expected to be used up to the end of the century, when it is planned to introduce new technology such as the flat screen tube and other new equipment which will require manpower retraining. The licensing agreements include the training abroad of highly skilled and university-educated personnel.

A school has existed inside EI since 1960 for the training of TV mechanics. It presently has about 600 students. Half of these are normally hired by EI while the remainder are employed in TV service centres or open their own repair shops. This school also retrains workers who need to upgrade their skills or who change their work (for instance from assembly workers to TV mechanics). The school has just successfully retrained 200 radio tube workers for TV tube production lines in a four-month programme. Part of the training of personnel for installation, repair and maintenance of new equipment is carried out by the equipment suppliers themselves.

In co-operation with other firms outside EI and with educational institutions, EI has established a special fund for retraining workers who are seeking employment. These courses are financed by firms which need manpower and by the local employment office.

In its present initial stages and with the scheduled introduction of three shifts, CCRTF will employ about 1,000 new people next year. Some 50% of these will be skilled and 25% semi-skilled or non-skilled workers. All will undergo on-the-job training which generally lasts four months. Some will be sent to school for further training. The main sources for the new personnel will be either EI operations that have become outdated or schools in the region. University-educated personnel will come from the electronics faculty at the University of Niş. Since most of the Niş students live in the area there should not be very much turnover. The university students undergo limited training for six months to a year inside the firm in what is called the "pripravnicki staz", a period in which they receive intensive instruction from experienced colleagues who prepare them for their tasks.

Conclusions & Test of Hypotheses

1. EI has a rather good record of introducing new techniques and marketing new products. This expertise has been acquired from well-known international electronics producers. There is little original innovation at EI as this, in this rapidly changing field, comes only from firms that are already well established and advanced. However, EI has been playing an important role in the exchange and diffusion of electronics expertise in Yugoslavia.

2. The firm is flexible in its work organisation and could not otherwise survive.

3. The Government supports technological innovation by not taxing income during the period of capital investment and by other measures. But it does not give exceptional support because technological change is regarded as a matter for the firm and because of the oligopolistic production structure of the Yugoslav electronics industry.

4. Due to its location and the rather high local level of unemployment, the firm is able to recruit and retain personnel at the levels it desires. The fact that female labour can be used in many jobs is a further advantage.

5. For CCRTF manufacturing under license, the skill of its workers and its production management personnel is the determining factor for success on the market. If the firm manufactured CRT tubes of its own design, then the R & D personnel would be important for CCRTF to compete.

6. The company is dependent on its management for survival. Furthermore, the quality of its skilled workers and production personnel is of high importance.

7. The introduction of colour CRT production has resulted in the acquisition of new skills, even though the company had had experience with black and white TV manufacturing.

8. The firm has a low ratio of researchers to total workforce but a relatively high ratio of university-educated personnel to total manpower (between 20 and 25%). The ratio of highly skilled workers to the total workforce is to be increased.

9. The Government has very little, if anything, to do with the policy of developing skills for high-technology industry. It exerts some influence on university and high school education by supporting measures that encourage young people to study engineering or select "productive professions". There also is some influence, but no particular Government policy on education and training for high-tech industry.

10. The firm -- in this case EI -- exerts considerable influence on education and training in the region. First, it has its own large intramural training school. Second, it is one of the founders of the special fund for retraining workers. Third, it has a decisive say in the curricula of those high schools which teach electronics. Fourth, the company is a founder of the faculty of electronics at Nis. EI's influence on education and training also reaches beyond the region to include the entire Socialist Republic of Serbia.

11. CCRTF has strong affiliations with foreign firms through its licensing agreement with Philips, and through the supply of equipment, raw materials and components. The foreign firms provide technical backup and do some training of skilled workers and engineers in the fields of machinery layout, repairs and maintenance.

12. EI acts as a diffuser of skills to some of its sub-contractors, but the CCRTF factory is little involved in skill dissemination.

13. The worker management system gives employees a decisive influence in all aspects of employment, education and training.

Main Conclusion

The introduction of new technology at CCRTF has raised problems of educating and training a large number of personnel. As far as workers and production management are concerned, this has been successfully solved. What remains is the problem of R & D personnel which will be critical for using foreign technology and developing the company's own new technology. This so far has not been tackled.

One should mention the complete lack of training for administrative and marketing personnel, which will become a future issue for the firm's successful development.

HYDRAULICS AND PNEUMATICS MANUFACTURING INDUSTRY
"PRVA PETOLETKA"

Data, Problems and Findings

Petoletka is the largest manufacturer of hydraulic and pneumatic products and components in Yugoslavia. Its product range includes pumps, tools and compressors.

The production of hydraulic and pneumatic equipment was started in 1953 on a license from the firm Wiser. Since then Petoletka has been expanding constantly with the introduction of new products and innovations as a result of a) its co-operation with the licensing partners and with scientific and research institutions and 2) its own developmental and creative work. Petoletka's production of hydraulics and pneumatics covers 75% of the domestic market and it also exports to Eastern, Western and other markets. Exports to the West amount to 10% of the total.

In order to survive on domestic and foreign markets, Petoletka must ensure technological independence, as well as the necessary in-house training that will produce highly trained and skilled manpower able to adapt to and keep up with technological change. There is constant need for mechanical workers and mechanical and electrical engineers.

Petoletka employs about 13,000 people of whom 5.17% have university degrees, 6.9% have a two-year college degree, 17.3% are high school graduates, 1.7% have completed compulsory education, 10.7% are highly qualified workers, 38.7% are qualified workers, 10.1% are semi-qualified and 9.4% are unskilled workers.

The enterprise comprises 13 independent basic organisations of associated labour (OOUR), the majority of which are located in Trstenik. Petoletka does not have its own scientific and research institute. Instead, R & D is done by special units within each OOUR. In addition to their regular work, a considerable number of workers, especially the skilled and highly skilled, work on improving the products and their processing with suggestions and new ideas. Payment for this is established by a special commission and is in proportion to the value of the proposals. During the last five years, more than 150 workers were rewarded for their ideas.

Personnel planning is carried out on the basis of short-, mid- and long-term proposals worked out in collaboration with Educational Centre, the Higher Technical Mechanical School at Trstenik and other educational institutions involved in satisfying Petoletka's needs. New employees are mainly young skilled workers with high school and university level education. University graduates are recruited mainly from the faculty of mechanical engineering at Belgrade University. Most production workers come from the Education Centre "Prva

Petoletka" while two-year college personnel come from the Higher Technical Mechanical school at Trstenik.

In order to obtain the necessary personnel, Petoletka grants scholarships to workers and university students. It also offers its personnel the possibility for further study under an arrangement in which the firm pays 50% of the costs, the remaining 50% being paid by the Self-Management Communities of Interest for Education. Grants for vocational schools are totally reimbursed by Petoletka. There are also arrangements for those willing to study while working, including a reduced number of working hours and the possibility of choosing convenient shifts. In return, the workers are expected to complete schooling within a defined period and to stay with the firm for a period not shorter than the time spent attending school.

Since the curricula of educational institutions are unable to keep up with technological advances, the frequent technological changes have required additional in-house training. Petoletka organises three-month courses within the enterprise for workers, and courses up to six months for personnel with higher education. Staff specialists are responsible for in-house training and the evaluation of training is carried out by a commission of experts.

Training includes co-called "sandwich programmes" for workers from other companies. These five- to 30-day courses are carried out within Petoletka's workshops and are usually related to certain hydraulic or pneumatic devices. The training programmes are worked out in advance in accordance with the specific needs of the trainees in groups not exceeding 15.

Technological change at Petoletka has had these effects on company personnel:

- Older personnel do not easily adapt to the changes so that Petoletka, as is the case with most enterprises, faces the problem of reassigning such people to other jobs;

- Younger staff are much better prepared to meet the demands of new techniques and equipment, although some groups of workers may be insufficiently trained;

- Skilled workers are better prepared for their jobs owing to close collaboration with the Educational Centre at Trstenik, while university educated personnel often require more time to become totally competent in specific jobs.

Conclusions & Test of Hypotheses

1. As the main Yugoslav manufacturer of hydraulics and pneumatics, Petoletka has not had a problem marketing its products on the domestic market. It also has made progress in exporting since its products are up to European and international standards. However, because of considerable competition, only 10% of its exports go to the West. Petoletka intends to improve the quality of its products so that exports to hard currency markets can be increased in the future. Petoletka has a history of frequent and efficient updating of its equipment. The result is a production programme that is varied and of high quality.

2. A number of reorganisations were carried out in the past with the installation of new equipment and the improvement of old technology, resulting in a significant increase in production. This flexibility , plus the educational and training programmes, are factors in the company's progress.

3. The Government does not give any direct financial support to Petoletka for technological research or for encouraging innovations. Petoletka has to find its own ways to stimulate creative ideas, and it has an agreement with its personnel to provide rewards for suggested innovations.

Government support consists of

- Granting licenses for the import of new equipment, depending on the value of goods exported to countries with convertible currencies;
- Partial financing of R & D projects through the so-called Communities for Science; and
- Paying 50 % of the training costs for certain employees.

4. The firm is able to recruit the needed personnel and retain them.

5. The qualifications of personnel in industries such as this are crucial to the success of the business. Educated and trained manpower are essential for modern technology especially when they are prepared to update their expertise to meet change.

6. Design specialists and highly skilled workers are of the utmost importance for the company's success.

7. A characteristic of Petoletka is its continuous introduction of new technology in production of hydraulics and pneumatics. In some sectors production is automated, CNC machines have been installed, etc. All these innovations have resulted in an enhancement of the skills of company workers and are expected to continue to do so in the future.

8. Out of 13,000 employees, 1.2% are engaged in R & D activities. This is small for such a technically advanced industry and in comparison with the situation in advanced countries. The industry is skill-intensive and 60% of the workforce is employed in production.

9. As in all other case studies, the Government does not directly support the development of skills for high-technology industries.

10. Since its foundation, Petoletka has had an exceptionally active policy of personnel education and training. An industrial school was already established at Trstenik in 1950 with the aim of training workers for Petoletka. This was later transformed into an Educational Centre which now has 2,000 students. The company's requirements are take into account in the curricula of the school. This collaboration is of mutual benefit. The Educational Centre provides Petoletka with personnel and Petoletka in return provides the centre with the necessary teaching staff. All the centre's practical training is carried out in Petoletka's workshops. Petoletka also provides the centre with financial aid to improve student living conditions, to organise study tours and for the purchase of machinery and tools.

Petoletka also collaborates closely with the Higher Technical School at Trstenik, where students are encouraged to join Petoletka immediately upon graduation or a year thereafter at the latest.

Furthermore, Petoletka collaborates with the faculty of mechanical engineering at the University of Belgrade where the curriculum takes account of the company's requirements. Petoletka organises post-graduate studies at the faculty if new technological information calls for it. All this results in Petoletka getting qualified graduates from the university.

Petoletka is a typical example of successful collaboration between an industrial enterprise and educational institutions for their mutual benefit.

11. Petoletka collaborates with a great number of foreign firms with whom it has licensing agreements, for instance, Wiser, Westinghouse, Martin Markel, Linde, etc. These contracts allow Petoletka to send its specialists abroad for training and, at the same time, the foreign firms send specialists to Petoletka to assist in training company personnel. Petoletka's production programme is still largely based on its licenses but it is encouraging development of its own products and these have increased over the last few years.

12. Petoletka attaches great importance to its relationships with the supplying firms and sub-contractors. This results in an exchange of information and technology and in the diffusion of skills.

13. Company workers, through their representatives in the self-management bodies, exert influence on educational policy. Anyone with an interest in the subject can participate actively in shaping programmes while the trade union, as a body within the workers' self-management system, also deals with certain aspects of training programmes.

MECHANICAL EQUIPMENT MANUFACTURING COMPANY (ILR)

Data, Findings and Problems

ILR is one of the most important machine tool manufacturers in Yugoslavia. Besides various kinds of machine tools, ILR makes computers for industrial purposes, hydraulics and pneumatics, equipment for energy and civil engineering projects and cast iron. Its production is based on its own developments as well as agreements with leading foreign firms. It is able to meet the demands of the domestic market by its high quality production despite sharp competition from other manufacturers. It exports to Eastern and Western markets as well as to the Third World. It faces certain difficulties in its exports to the West.

The high level of technology in industries such as this, plus the need for maintaining and winning new markets, influence the level of education and skill required from all employees. Technological changes impose growing demands for personnel with higher education, for highly skilled workers, for specialists in new jobs, and personnel who are able to assist in introducing and maintaining new equipment and who can work in information processing and on computer applications.

ILR employs 8,000 people, 700 of whom have a university degree, 2,000 who hold two-year college and high school qualifications, 4,500 who are skilled and highly skilled workers and 800 of whom are unskilled workers. The firm has 10 plants with the following common functions centralised: research, engineering, investment maintenance, commercial and banking activities and personnel control. ILR has its own research institute which deals mainly with existing and new techniques and components of direct importance to the company. Besides the central research institute , there are research units within the plants, and there is am independent design unit.

One-year and five-year manpower plans are drawn up in accordance with short-, mid- and long-term production plans. New employees are mostly young people between 18 and 24, mainly university graduates or skilled and highly skilled workers in the mechanical and electro-technical fields. The graduates are mostly recruited from Belgrade University's Mechanical and Electrical Engineering faculties while other workers are recruited from vocational schools in the Belgrade area.

In order to secure the necessary personnel, ILR awards scholarships to certain personnel on the condition that they continue to work for the company after completing their schooling. Due to inadequate instruction in educational institutions which are unable to keep up with frequent technological changes, there is on-the-job training carried out in the firm for one to two years for skilled workers and one to three years for personnel with higher education. This

programme provides practical experience that allows trainees to gradually move on to more skilled jobs which can be performed with less supervision.

Frequent technological changes have created a problem for older workers who are unable to adapt. A certain number of these have to be transferred to simpler jobs while others are assigned to administrative jobs.

As ILR is located in an area where there are good university faculties and vocational schools, the company does not face a great shortage of vocational skills. Nevertheless, there are shortages among personnel of higher education, but it is being solved by the establishment of required departments at local higher education institutions. The flow of skilled workers is satisfactory since an Educational Centre has been recently established whose task is to cater exclusively to ILR's needs.

The future direction of ILR is to extend its exports. This will call for high quality products, plus the development of new products and the corresponding need for new manufacturing processes. This in turn necessitates personnel with satisfactory educational and vocational qualifications, provided by local educational institutions and by on-the-job training. This is an ongoing process which requires individual workers who can adapt.

Conclusions &Test of Hypotheses

1. During the last decade, ILR has achieved good results in marketing new and adapted products in the domestic and East European markets. About 55% of its total sales went abroad. Exports to Western markets were originally small because of an inability to meet quality standards. This situation has now improved, although the difficulties remain considerable due to competition. ILR's production history is similar to that of the world's leading firms, so that their solutions to problems could be adapted to the needs and conditions of ILR.

2. In recent years, several work reorganisation plans were undertaken. These never completely realised their goals, except for the most recent in 1984, which produced good results. The aim of this reorganisation was to improve design, production and marketing and facilitate further expansion and co-operation with other organisations in Yugoslavia and abroad.

3. The Government supports innovations through granting import licenses for new equipment such as laboratory installations which are imported free of duty. Grants for R & D are given through the Communities for Science which partially finance some R & D projects. There is also exemption from taxes for newly employed personnel.

The import of foreign expertise and equipment has been considerably restricted in the last few years and as a consequence

the company is devoting more effort to its own research. There is dissatisfaction among ILR managers with Government support. The management feels that there should be exemption from taxes for new products and processes which are in the broad public interest, and that there should be direct Government financing for pilot systems and projects that are important for the country, especially if they are a result of extensive work.

4. The firm is able to recruit and retain the personnel it needs at the desired levels.

5. In order to reach the desired product quality, which is a major factor for survival and success on the market, it is necessary to have the qualified personnel for production and design.

6. Research and development personnel, design engineers, highly skilled workers, marketing specialists and production managers are most important for the company's success.

7. New equipment used in production at ILR include two-handed robots, computerised automated machines, CNC machine tools, and the first elements of a computer-operated transportation system. All these require a high level of expertise and, as further technological developments occur, a significant growth of skills will also take place.

8. Out of 8,000 employees, 3.2% are engaged in R & D. This is a relatively high percentage for Yugoslavia, although it still remains below that in similar international firms. Skill intensive manpower totals 54% of the workforce which is considered quite high for this sort of industry with automated production processes.

9. As in other cases, there is no direct Government support for developing high-tech skills.

10. ILR has many possibilities for collaboration with educational institutions due to the large number of these in the region. It works mostly with the faculties of mechanical and electrical engineering at Belgrade University which recently enrolled an additional 20 students due to the dearth of mechanical engineers for production processes. These students were given ILR grants. On the request of manufacturers, the university has established a special department for computer techniques and information processing within the electrical engineering faculty.

Recently a new Educational Centre was established within ILR to train production workers. This centre is financed by Self-Management Communities of Interest for Education. The centre provides ILR with the personnel it needs, while ILR assists the centre by providing instructors and furnishing equipment for practical training. Since ILR regards the curriculum as somewhat obsolete, it is assisting in efforts to bring it up to date.

11. ILR collaborates with a large number of international firms, not with licensing arrangements but with production contracts which account for 26% of total production. These contracts guarantee complete independence in the production and marketing of ILR products but ILR is obligated to pay fees to the foreign firms for the use of their technical documentation. The contracts provide for exchange of assistance in marketing and in other fields.

12. Since ILR is largely independent in its production, it does not pass on much skill and knowledge to other firms.

13. The self-management bodies of ILR influence educational policy in numerous ways. Workers representatives have a voice in granting scholarships for post-graduate study, in financing study tours, in exempting workers from certain work obligations so that they can devote time to study, and in other matters. The role of the trade union is less evident although it is present in the shaping of general educational policy.

TERMOVENT

Data, Problems and Findings

Because of its capacity and the diversity of its output Termovent plays an important role in the Yugoslav economy. Some 90% of its products are made from the main components which it manufactures--ventilators, exchangers and filters. As Termovent produces its own basic parts, it has no licensing agreements and has full control over the supply and consumption of materials used. Imports are practically zero except when special needs arise. Owing to the high quality of its products, as well as marketing and service facilities, it meets the demands of the domestic market without problems. It also exports to Eastern and Western markets and to developing countries and Latin America.

Termovent concentrates a great deal on developing new technologies and company strategy is based on three key questions:

- What further investments in equipment are needed to improve the existing production cycle?
- What firms will be likely competitors in the future?
- What markets are likely to be promising in the future and how can the competition be matched?

As top level development can not go on without high grade personnel, Termovent gives special attention to this matter. Owing to its location in Belgrade where there are many faculties and high schools, Termovent does not face a recruiting problem. The best graduates come to work at Termovent. Production workers are available whenever they are needed.

The company employs 1,400 people of whom 11.2% have university degrees, 1.2% have two-year college degrees, 8.1% are high school graduates, 7.1% are highly skilled workers, 45.1% are skilled workers, 7.7% are semi-skilled and 10.3% are unskilled. Since 1985 Termovent has been organised on a macro and micro business principle. The internal structure is a matrix composed of a series of strategic business units which are independent but work in co-operation. There are seven plants most of which are located outside Belgrade. There is no separate research institute. Most R & D work is done in the Development Factory in Belgrade which employs about 94% of all the university-educated personnel.Since this plant is the centre for development, for business research and for marketing, it is considered the mainspring for the company's successful, up-to-date business policy.

As with other organisations, production planning is done for the short-, mid- and long-term and the recruiting of new workers conforms to this. Hiring is co-ordinated with development programmes for new technology, marketing and export. The new employees are

recruited from the university faculties and vocational schools in Belgrade and vicinity.

Termovent's strategy is that 70% of its production shall be ultimately exported, a policy that calls for high quality products, competitive prices and good marketing . As a consequence, there is a constantly increasing requirement for educated personnel and for changes in the length and breadth of the subjects covered in their training programmes. It is anticipated that Termovent will be employing around 3,000 people by the year 1990 of whom 400 will require university degrees.

Since the educational institutions are unable to keep up with changes, additional on-the-job training within the company is necessary. In-house training for production workers lasts up to one year while that for university personnel is up to three years. Such training helps keep the personnel aware of the latest developments in technology and it bridges the gap between regular education and technological advances.

Conclusions & Test of Hypotheses

1. Despite an unfavourable situation in the domestic market in the last few years due to rising inflation, foreign indebtedness and other factors, Termovent has succeeded in maintaining full production. The company has a network of sales representatives throughout Yugoslavia. Similarly no problems have arisen on foreign markets and it is hoped that the goal of 70% exports can be realised in the years to come. Termovent is selling less and less directly while increasing its sales through associations and joint ventures. In the last few years, the firm has introduced many new processes and products of its own design and this expansion continues.

2. Termovent demonstrates significant flexibility through its macro and micro organisation, its centralised business administration and policy making on the one hand and its decentralised delegation of responsibilities and authority on the other. By establishing a matrix type organisation, the flow of information, technological knowledge and experience, is enhanced. Close links are established between planning and those responsible for carrying out projects. The use of the workforce is efficient and there is no problem of surplus manpower. There is little job rotation or duplication of work.

3. According to the Termovent management, Government support is inadequate. Except for obtaining Government import licenses, Termovent relies entirely on its own resources and assistance from its suppliers and contractors.

4. Termovent is able to recruit and keep the desired level of manpower.

5. Success in foreign markets depends on quality, competitive prices and marketing. For this it is necessary to have specially trained

personnel who can deal with the demanding aspects of foreign competition.

6. R & D personnel, engineers, highly skilled workers and marketing specialists are essential for the survival and success of Termovent.

7. Since it uses a high level of expertise in producing its final products, Termovent is able to design and produce complicated technological systems such as air-conditioning equipment, refrigeration tunnels, etc. It is now directing its main effort to increasing the complexity of such systems and developing new ones.

8. Out of 1,400 employees, 4% are researchers, a high percentage for Yugoslav enterprises. Since Termovent's rapid development is relatively recent, it is expected that the number of researchers will grow considerably in the years ahead.

9. Government support for the advancement of training is minimal as in other cases.

10. Practical progress in scientific advancement cannot be achieved without close co-operation between institutional research and industry. Termovent therefore co-operates closely with nine faculties in order to obtain mechanical and other technological engineers, agricultural experts, etc. The co-ordination with educational institutions means that graduate students can become productive immediately after finishing their studies. As Termovent does not have its own Educational Centre it co-operates closely with vocational schools especially in the introduction of new technology. It expects closer co-operation in the future, resulting in formation of classes specifically for training personnel for Termovent.

11. Termovent co-operates and consults with a number of domestic and foreign institutes, such as the Institute for Economic Science, the Institute Kirilo Savic, the Mining Institute, etc. in Yugoslavia and abroad with, for example, the Institute Karpov in the U.S.S.R.

12. There is no transfer or diffusion of skills between Termovent and its suppliers.

13. The role of workers and the trade unions is the same as in previous case studies.

TRAINING IMPLICATIONS OF TECHNOLOGICAL CHANGE IN MANUFACTURING IN NEW INDUSTRIAL COUNTRIES: THE YUGOSLAVIA CASE

PART 3

GENERALISATIONS ABOUT CASE STUDIES

Besides the five cases studied here in detail, other cases have been investigated and the findings relating to them are included in reaching the following general conclusions.

1. Firms greatly affected by technological change, particularly those in generic technologies, have a good production and marketing record. Aside from the usual problems which accompany any successful business, the firms have coped with technological change and have successfully introduced and marketed new products. In each case studied, it has been shown that the introduction of new product and processing technology has been made possible by flexible work organisation and use of manpower.

2. All the cases show that the successful introduction of new technology is strongly influenced by the skills and abilities of company personnel, specifically the following groups of employees: managers, researchers, highly skilled productive workers and marketing specialists. The firms studied have no important problems in recruiting personnel, except that there are inadequate sources of trained people. The supply of microelectronic engineers, mechanical engineers and other specialists is limited.

   To resolve this problem, the firms are putting strong pressure on educational institutions as in the case of the electronic and mechanical engineering schools. In some cases, firms have specific contracts with universities for the supply of qualified labour. In other cases, firms organise their own Educational Centres so as to be certain of getting a supply of labour with the right skills. Some important groups of staff, however, are far away from appropriate educational and training facilities and this may affect production and marketing. The main overall problem for meeting technological change is the inability of educational institutions to respond adequately to change and to provide trained manpower.

3. The Government's industrial policy is directed mainly to ensuring a growth of production and exports in order to control inflation and establish a positive balance of payments. This policy does not restrict technological change and progress but, at the same time, the Government does not take measures to actively support innovation. Technological innovation is thus

the problem of each company. There is still a lack of understanding of the role which technology plays in international trade and competition which explains the lack of a national policy on innovation or, at least, the lack of strong official support for modernisation.

4. Expansion and development of the educational system is hindered by the current economic situation. The amount of funds allocated to education is becoming very limited, resulting in a decrease in the number of students. The poor economic climate unfortunately has coincided with the need for radical technological changes. The reaction of some state governments has been to limit the number of university students who are not working on courses essential for meeting the needs of new technology. In an indirect sense, this can be considered as support for the development of high-tech skills.

5. Under existing Yugoslav practices, industry plays a strong role in determining educational curricula and in the enrollment policies of universities and other higher educational institutions. Industry can in fact make contracts with such institutions to meet its specific needs. Industrial organisations can also establish, if they need to, their own Educational Centres and schools. However, these opportunities are not fully used mostly due to the limited amount of money available for education.

6. In most of the cases studied, the companies have good connections with foreign firms for co-operation, acquisition of technology, technical backup and for some training. In all cases, technological progress develops competence in international co-operation but this is insufficient in the field of training.

   Firms making radical changes, particularly the larger ones, are diffusers of technology, mostly to their sub-contractors and suppliers but not to a large extent.

   Employees in general have privileges associated with education and training such as the possibility to choose shifts when engaged in supplementary education and training, shorter working days with full pay, fully paid days for preparing examinations, and reimbursement of expenses for travelling and books.

   Trade unions and workers take part in all decisions concerning employment and training, including socially acceptable decisions on how to deal with older workers and their problems with new technology.

Finally, the situation in Yugoslavia can be summarised as follows:

- The introduction of new technology has created many new needs in education and training of personnel;

- This is realised by Yugoslav firms but not to the extent of engaging in adequate long-range planning for personnel recruitment, promotion and training;
- Managers, researchers, engineers, highly skilled workers, planners and marketing specialists are of utmost importance for successful production and marketing;
- In principle, the structure of the educational and training system is excellent but due to inertia it does not respond efficiently and promptly enough to meet the needs of high technology;
- The greatest educational gap is in the provision of instruction for managers and marketing specialists;
- The new technology is extending the knowledge and ability of young employees but diffusion of this through the entire industrial system is slow; and
- The Government has not yet devised specific measures to support technology innovation and to promote the development in education and training institutions of the skills needed now and in the future.